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ARM WEAR TYPE COMMUNICATION DEVICE AND HIGH DIELECTRIC CHIP ANTENNA

BACKGROUND OF THE INVENTION

Field of the Invention

OK to Enter
JC
9/8/03

The present invention relates to an arm wearable communication device, which is worn on a user's arm, and to a high dielectric chip antenna therefor.

Description of the Prior Art

An arm wearable communication device is a piece of super-small communication equipment, which is miniaturized to a degree by which a self-contained body containing an apparatus required for achieving the communication can be worn on a user's arm. Though the body is of a super-small type, the radio communication for transmitting and receiving communication signals necessarily requires an antenna. With respect to the antenna, many conventional arm wearable communication devices have adopted a helical antenna or a whip antenna each of which projects from the chassis of the body similarly to conventional radio equipment. Then, when carrying out the transmission and reception, a call is made with an arm having the whip antenna out stretched, or a call is made with an earphone attached to the body serving as an antenna.

In addition, as for the arm wearable communication device in which an antenna is mounted in a special form, there

are known the communication device in which a loop antenna is disposed by utilizing the length of a belt by which the body is worn to an arm (refer to Japanese Patent Application Laid-open No. Hei 04-176241, and Japanese Patent Application Laid-open No. Hei 07-283632), and the communication device in which the above-mentioned earphone is used as the antenna as well (refer to Japanese Patent Application Laid-open No. 2000-286939). In such conventional arm wearable communication devices, it becomes the premise that a call is made with such a communication device worn to an arm. That is, in the above-mentioned arm wearable communication device, it can safely be said that calls are made and received with the equipment fixed to the arm. For this reason, if the antenna is also small with the same idea as that in the conventional radio communication device as the base, the antenna itself does not need to be particularly special.

On the contrary, recently, the arm wear means of the arm wearable communication device has been changed from the fixed type to the type in which the arm wear means is readily detachable from the user's arm to use the device. For example, opposite sides of the body of the communication device have two separate arm holders. When the communication device is worn to an arm, an arm is held between these arm holders, while when the communication device is detached from an arm, an arm is released by opening these arm holders. In such a communication device, by utilizing easily detachable arm holders, use may be done as in

conventional communication devices, e.g., a form of use becomes possible in which the communication device is held by one hand and put up to the user's ear and mouth. The arm wearable communication device, which can be worn on the user's arm and can also be put up to an ear and a mouth, must be disposed by taking into consideration the communication state when the communication device is being worn to an arm as well as the body is being held with respect to the antenna.

However, since the conventional helical antenna or the like is disposed in such a way as to project from the chassis of the body, it is easy to be hit against other objects when being carried with an arm and hence is easily damaged. In addition, in order to reduce the influence of the transmission and reception sensitivity provided by the human body, consideration needs to be given to the manner in which the whip antenna is stretched. However, it is not realistic for the antenna to be stretched in the state of waiting for the reception of a call. In the loop antenna provided within the band, the length of the antenna is largely changed when being worn closely to an arm, i.e., the human body, and when being released to lie in free space, and between when the band is coupled into one piece through use of a clamp and when the band is not being into one piece. It is well known that if the length of the antenna is changed, then a change in the sensitivity becomes large, especially in the high frequency band of several hundreds of MHz. In addition, it is

also known that the antenna suffers from the influence of the electric wave shielding effect provided by the chassis coating material.

SUMMARY OF THE INVENTION

In the light of the foregoing, the present invention has been made in order to solve the above-mentioned problems associated with the prior art, and it is therefore an object of the present invention to provide an antenna disposition structure of an arm wearable communication device which is convenient in the state in which a communication device body is worn on a user's arm or in the state in which a communication device is detached from the arm and held by one hand (and a high dielectric chip antenna).

In order to solve the above-mentioned problems, according to the present invention, there is provided an arm wearable communication device which includes a communication device body for transmitting and receiving a signal, a wearable body which is pivotally fixed to the communication device body in order to be worn on an arm, a sound unit which is provide dint he wearable body, and an antenna which is located between the sound unit and the communication device body and which is provided in the wearable body.

According to another aspect of the present invention, there is provided an arm wearable type communication device, in which a plurality of wearable bodies are disposed in positions

facing a communication device body, and the communication device body is adapted to compare the reception states of signals which are respectively obtained from the plurality of antennas provided in the plurality of wearable bodies, respectively.

According to the present invention, there is provided an arm wearable communication device, in which the wearable body has a curved part having a curvature which is smaller than that of a part of the physical body when a part of the wearable body is held to the part of the physical body, and the antenna is provided in the curved part.

According to the present invention, there is provided an arm wearable communication device, in which the antenna is formed in such a way that a pattern made of a conductor foil is formed on the surface of a material which is obtained by mixing a resin with a high dielectric material so as to take on a chip shape.

According to the present invention, there is provided a high dielectric chip antenna which includes a conductor foil which is provided on the surface of a chip-shaped material which is obtained by mixing a resin with a high dielectric material, and a pattern which is formed on the surface on the conductor foil.

The arm wearable communication device is comprised of a communication device body, and wearable bodies for wearing the communication device body on an arm. As for the wearable body,

there are an arm holder type band with which an arm is held by two arm holders, in addition to a belt type band with which an arm is held by a uniform material such as a belt, and a band with which multiple pieces are coupled in such a way as to make a loop around an arm. Antennas of the arm wearable communication device according to the present invention are not accommodated in the chassis constituting the communication device body, but are mainly accommodated in the wearable bodies and are electrically connected to the communication device body through the coupling parts between these antennas and the wear bodies. Therefore, when the communication device is being worn on an arm, the transmission and reception of the electric wave are carried out on the radius side and the ulna side of an arm. When the communication device body is detached from an arm to be put up to an ear in order to be used, there are carried out the transmission and reception of the electric wave in which the reduction of the antenna performance due to grasping the communication device body is avoided.

In general, while in the arm wearable communication device, a coating is applied to the facing of the body thereof and the wearable bodies, this coating has an electric wave shielding function. Therefore, in the present invention, in order to avoid that function, the antennas are respectively accommodated in wearable bodies which do not have the coating applied thereto. However, in this case, it is also contained

therein that only the parts each having the antenna accommodated therein suffer the masking in order to save the coating. In addition, the ceramics coating and the like are not contained in the coating. As for the kind of antenna, a chip antenna having a flat shape is adopted. Thus, the antenna of interest, even if the wear body is curved, can be readily accommodated in the wearable body. In addition, as the chip antenna, there is adopted one which has the directivity on a single face. Here, as for the chip antenna, there are a high dielectric chip antenna and a metal chip antenna.

The fact that the communication device body is worn to an arm by the wearable body or bodies is as stated above. Then, in the case where the wearable body is the so-called belt type, the chip antennas are disposed in the parts which are located on opposite sides of the communication device body, i.e., the wearable bodies of interest. In the case as well of the band type wearable body which is formed by coupling multiple pieces to one another or the arm holder type wearable body with which an arm is held by two pieces, the chip antennas are disposed in the positions similar thereto. That is, the two antennas are disposed in such a way as to hold the communication device body between them, and are electrically connected to the communication device body. In such a manner, in the state in which the communication device body is worn to an arm as well as in the state in which the communication device body is held by one hand,

the two antennas which are disposed apart from each other spatially are disposed in positions where the degradation of the reception sensitivity due to the human body can be avoided.

In addition, the term high dielectric material means a material having a dielectric constant which is higher than that of air, and more specifically, such materials include ceramics, a plastic resin, a metallic plate and the like. As used herein, the term, ceramics includes material which is obtained by mixing a resin with a ceramic. As for the chip antenna utilizing such a high dielectric material, there is taken as an example one in which the antenna pattern is formed on the high dielectric material of interest using a conductor foil. This, there are a helical pattern, a reverse F pattern and the like.

In the present invention, the arm wearable communication device in which the wearable body is not of a belt type, but is of an arm holder type having two arm holders is described. In general, the two arm holders are coupled to the communication device body on opposite sides of the communication device body, and pivotally hold an arm in the coupling part. As a result, when the communication device body is worn on an arm, the two antennas which are respectively accommodated in the two arm holders are respectively located on the radius side and the ulna side of an arm. In addition, when the communication device body is held by one hand, the two arm holders which are taken off from the arm are located apart form a hand holding the

communication device body. Since the antennas are accommodated in the respective arm holders, it is possible to avoid the influence of the reception degradation function due to the human body.

If it is assumed that the above-mentioned arm holders are worn/detached to/from an arm by the simple pivotal movement, then the degree of freedom of the positions which the arm holders of interest have with respect to the communication device body may be reduced. However, if it is taken into consideration that the antennas are accommodated in the respective arm holders, that fact means that the antenna positions with respect to the communication device body are further stabilized. The two antennas, similarly to the foregoing, are disposed in such a way as to hold the communication device body between them to be electrically coupled to the body, respectively. In such a way, in the state in which the communication device body is worn to an arm as well as in the state in which the communication device body is held by one hand, the two antennas which are disposed apart from each other spatially are disposed in the positions where the degradation of the reception sensitivity due to the human body can be avoided.

In general, the arm wearable communication device is additionally provided with a speaker and a microphone. Them, when the body is held by one hand, the wearable body on the speaker side is put to the user's mouth and ear to be used. In

order to wear the communication device body to an arm, the wearable body may adopt the various shapes and structures. For this reason, the two antennas may not be respectively disposed on the both sides of the communication device in some cases. In such cases, the one chip antenna is accommodated in the wearable body on the speaker side. In such construction as well, when the communication device body is worn on an arm as well as when the communication device body is being held by one hand, the grounding effect due to the human body is avoided and transmission and reception having suitable directivity become possible.

As described above, it is known that the antenna suffers from the influence of the electric wave shielding function of the coating for the chassis in which the antenna is accommodated. In the present invention, the wearable bodies in which the antennas is accommodated. In the present invention, the wearable bodies in which the antennas are respectively accommodated are coated with a ceramic such as an acrylic glass, whereby it is possible to prevent the electric wear shielding function as when the typical coating is applied. In addition, the finishing of the wear body becomes smooth while preventing the above-mentioned function.

The antenna is electrically connected from a feeding point to the communication device. Thereby, transmission and reception in the communication device in the communication device

becomes possible. The high dielectric chip antenna according to the present invention is constructed by applying an antenna pattern made of a conductive foil to the material having a high dielectric constant. As typical antenna patterns, there are known the reverse F type, the helical type, the $\lambda/4$ short-circuiting microstrip, and the like.

High dielectric, in addition to dielectric itself, includes therein a material which is obtained by mixing a resin with a ceramic. For such high dielectric, a die forming becomes possible. Thereby, the shape of the high dielectric chip antenna according to the present invention can be fitted to the various shapes which the wearable body adapted to be fitted to the arm shape has. In addition, this high dielectric chip antenna can be accommodated in the wearable body of interest. Such a high dielectric chip antenna can also be designed in such a way that the flat face of the wearable body has directivity depending on the installation direction. If the design is made in such a way that the single face that the single face has directivity, then it is possible to maintain the directivity which is convenient for when the body is being worn to an arm as well as the body is being held by one hand.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

A preferred form of the present invention is illustrated in the accompanying drawings in which:

Fig. 1 is a conceptual view showing a structure of an arm wear type communication device according to a first embodiment of the present invention;

Fig. 2 is an exterior view showing the actual use form of an arm wear type communication device;

Fig. 3 is a perspective view showing construction of an example of a chip antenna;

Fig. 4 is an exploded view showing the state in which a chip antenna is inserted into an arm holder; and

Fig. 5 is a conceptual view showing a structure of an arm wear type communication device according to a second embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will hereinafter be described in detail with reference to the accompanying drawings. However, it is to be understood that the present invention is not intended to be limited to the embodiments.

(Embodiment 1)

Fig. 1 is a conceptual view showing a structure of an arm wearable communication device according to a first embodiment of the present invention. A first arm holder 2 and a second arm holder 3 are provided as wearable bodies in both sides of a communication device body 1. The arm holders 2 and 3 are pivotably mounted by hinges which are respectively provided in

the coupling parts between the arm holders 2 and 3 and the communication device body 1. In such a manner, the wearable body may be either an arm holder having two arm holders or of a type which is constructed by coupling one arm holder or three or more arm holders to one another.

Chip antennas 4 and 5 each having a generally flat (or, if desired, a curved shape are respectively disposed inside the above-mentioned arm holders 2 and 3. The communication device body 1 is electrically connected to the chip antennas 4 and 5 through the respective coupling parts, and is adapted to demodulate a received signal which has been received through the chip antennas 4 and 5 and to modulate a user's voice for the transmission. In addition, the communication device body 1 is equipped with a console panel 26 (buttons, as shown in Fig. 5), a liquid crystal panel 27 and the like which are utilized by a communicator.

In addition, a traditional coating is not applied to the arm holders 2 and 3, and the surfaces of the arm holders 2 and 3 are coated instead with a ceramic such as an acrylic glass. The reason that the traditional coating is not applied to the arm holders 2 and 3 is to avoid the electric wave shielding function of the coating. Then, if chip antennas 4 and 5 each having excellent directivity are utilized, then only the parts in which the chip antennas 4 and 5 are accommodated may be subjected to the masking processing in order to save the coating.

Fig. 2 is an exterior view showing the actual use form of the arm wearable communication device. As shown in the figure, when the communication device body is being worn on a user's arm, the chip antennas 4 and 5 are located on the radius side 6 and the ulna side 7 of the arm to carry out signal transmission and reception. In the case where the communication device body 1 is detached from an arm to be put up to the user's ear in order to be used, transmission and reception of the signal in which the grounding effect due to the human body is avoided are carried out.

Fig. 3 is a perspective view showing construction of an example of a chip antenna. Normally, a chip antenna 8 includes a grounding pattern 10 formed on an antenna substrate 9, a dielectric material 11 which is disposed on the upper part of the grounding pattern 10, and a conductor foil called a patch pattern 12 which is provided on the upper surface of the dielectric material 11. The chip antenna 8 shown in the figure is electrically connected to the communication device from a feeding point 13 provided ont eh side part of the dielectric material 11.

A short-circuiting part 14 for causing the patch pattern 12 and the grounding pattern 10 to conduct is provided in the vicinity of the feeding point 13 to form the so-called rectangle reverse F type chip antenna. As for the patch pattern, in addition thereto, the helical pattern or the like may be formed. In addition, the $\lambda/4$ short-circuiting microstrip type

antenna may also be formed depending on the feeding point, the grounding point, the size of the rectangular patch pattern, and the like.

As for the dielectric material, various kinds of materials may be utilized. That is, a ceramic by itself or a material which is obtained by mixing a resin such as plastic with a ceramic may also be utilized. As a result, it is possible to form a high dielectric material having a high dielectric constant. In addition,, for such for such a high dielectric material utilizing the resin, die forming such as injection molding becomes possible. As a result, the shape of the high dielectric chip antenna according to the first embodiment can be fitted to the various shapes of the wearable bodies, e.g., the curved shape and the flat shape, which wearable bodies adapted to be fitted to the arm shape have. For this reason, the high dielectric chip antenna can be accommodated in the wearable body of interest without spoiling the appearance.

In the high dielectric chip antenna described above, directivity can be provided in the direction perpendicular to the antenna pattern. By utilizing this fact, if the antenna surface having the directivity of interest is disposed on the curved convex side of the wearable body, in the state in which the communication device is worn to an arm as well as in the state in which the communication device is held by one hand, excellent communication in which the influence of the human body is avoided becomes possible.

Fig. 4 is an exploded view showing an example of the state in which the chip antenna is inserted into the arm holder. In this case, there is shown an example in which the chip antenna 5 is inserted into the arm holder 3 on the radius die of the two arm holders 2 and 3. The arm holder 3 has in the body the space in which the chip antenna 5 and an antenna substrate 15 are accommodated, and is covered with an arm holder cover 16 using screws 17. In addition, the arm holder 3 is coupled to the communication device body 1, Then, an antenna coaxial cable 20 through which a chip antenna feeding point 19 is electrically connected to the communication device body 1 is introduced into a communication hole 18 which is provided in the coupling part of the arm holder 3 directed to the communication device body 1. As a result, the chip antenna 5 achieves its function without appearing in the exterior appearance. However, while in this case, the simples insertion example is shown, the insertion construction is not intended to be limited thereto. That is, the arm holder 3 and the arm holder cover 16 may be made slidable or engageable.

In addition, when the communication device body is being worn to an arm, the two antennas which are respectively accommodated in the two arm holders are located on the radius side and the ulna side of an arm, respectively. In addition, when the communication device body is being held by one hand, the two arm holders in the state in which they are taken off from an

arm are located apart from a hand holding the communication device body. The arm wearable communication device is basically a mobile communication device. Mobile telecommunication, unlike fixed station telecommunications, easily suffer from multiple fading phenomena due to wave reflection by obstructions such as buildings, or the diffracted electric wave. As described above, the fact that the two antennas are located apart from each other spatially is advantageous in terms of avoiding the influence of multiple fading.

As described above, according to the arm wear type communication device of the first embodiment of the present invention, when the communication device body is detached from an arm to be held by one hand as well as when the communication device body is being worn on an arm, the influence of the human body is avoided so that excellent telecommunication becomes possible. In addition, the arm wearable communication device is free from the electric wave shielding effect caused by coating. Also, by paying attention to the disposition of the antennas each having the directivity which is optimal for when the communication device is being worn to an arm and when the communication device body is being held by one hand, the chip antennas each of which has a flat shape and has a single directivity are accommodated in the wearable bodies, respectively. As a result, the antenna transmission and reception adapted to the actual use form of the communication

device become possible. If the wearable body is of th arm holder type, then the shift from the state in which the communication device body is being worn to an arm to the state in which the body is being held by one hand can be quickly readily carried out and also it is possible to hold the antennas in the optimal positions. Furthermore, if the chip antennas are respectively accommodated in the wearable bodies which are respectively disposed on opposite sides of the communication device body, then the diversity reception also becomes possible by using the two chip antennas which are disposed apart from each other spatially. In this case, both of the chip antennas may have the same characteristics or may have a performance in which the characteristics int eh polarization direction ar different.

(Embodiment 2)

Fig. 5 is a conceptual view showing an arm wearable communication device according to a second embodiment of the present invention. In the figure, a first arm holder 21 and a second holder 22 are provided as the wearable bodies on the both sides of the communication device body 1, respectively, as in the first embodiment. In addition, the arm holders 21 and 22 are pivotably provided through hinges 23 which are respectively provided in the coupling parts between these arm holders 21 and 22, and the communication device body 1 is also the same as that of the first embodiment. Here, the wearable body may be of the arm holder type having two pieces, or may be constructed by only one or three or more coupling members.

A chip antenna 24 having a flat shape is disposed in the arm holder 21 which is located on the speaker side, when being worn to an arm, of the above-mentioned two arm holders 21 and 22. The communication device body 1 is electrically connected to the above-mentioned chip antenna 24 through the coupling part and is adapted to demodulate the electric wave which has been received through the chip antenna 24 and to modulate the voice for the transmission. In addition, the communication device body 1 is equipped with manipulation buttons 26 and a liquid crystal panel 27 which a communicator utilizes. The arm holders 21 and 22 are equipped with a speaker 28 and a microphone 29, respectively.

In addition, a point that the surfaces of the arm holders 21 and 22 have no coating, but are coated with ceramics such as an acrylic glass is the same as that of the first embodiment. As described in the first embodiment, the wrist bone is constituted by the two bones, i.e., the radius on the side of the thumb and the ulna on the side of the little finger. The arm holders 21 and 22 according to the second embodiment of the present invention are worn in such a way as to envelop both of the radius and the ulna of an arm.

The arm holders 21 and 22 may adopt the various shapes and structures in order to wear the communication device body 1 to an arm. In the case where the antenna chips can not be respectively disposed in the arm holders 21 and 22 on the both

sides of the communication device body 1 due to such shapes, structures and the like, one chip antenna is accommodated in the arm holder 21 on the speaker side. Even when such construction is adopted, the transmission and reception can be carried out with the excellent efficiency when the communication device body 1 is being worn to an arm and when the communication device body 1 is being held by one hand.

Therefore, according to the arm wear type communication device of the second embodiment of the present invention, the transmission and reception can be efficiently carried out with the influence of the human body avoided when the communication device body is being worn to an arm and when the communication device body is being held by one hand.

As described above, according to the arm wear type communication device of the present invention, the excellent communication becomes possible with the influence of the human body avoided when the arm wear type communication device is detached from an arm to hold the communication device body by one hand as well as when th arm wear type communication device is being worn to an arm. In addition, this arm wear type communication device does not suffer the electric wave shielding effect due to the coating at all. Also, by paying attention to the antenna disposition having the optimal directivity for when the arm wear type communication device is being worn to an arm and when the communication device body is being held by one hand,

the chip antennas each of which has the flat shape and has the single directivity are accommodated in the wear bodies, respectively. As a result, the antenna transmission and reception adapted to the actual use form of the communication device can be carried out.

In addition, according to the arm wear type communication device of the present invention, when the communication device is being worn to an arm and when the communication device is being held by one hand, the degradation of the reception sensitivity due to the human body can be avoided so that the suitable transmission and reception become possible. In addition, the diversity transmission and reception become possible using the two antennas which are disposed apart from each other spatially. Also, if utilizing the high dielectric chip antenna, the small and high performance antenna can be accommodated in the wear body which may be formed into the various shapes.

In addition, according to the arm wear type communication device of the present invention, it is possible to obtain the property of the arm holder type wear body in which the shift from the state in which the body is being worn to an arm to the state in which the body is being held by one hand can be quickly carried out, and also it is possible to hold the stable antenna position. If the antennas are respecively accommodated in the two pieces of wear bodies which are respectively disposed

on the both sides of the communication device body, in the state in which the communication device body is held by one hand as well as in the state in which the communication device body is worn to an arm, it is possible to avoid the degradation of the reception sensitivity due to the human body. In addition, similarly to the foregoing, the diversity reception becomes possible using the two antennas which are disposed apart form each other spatially.

In addition, according to the arm wear type communication device of the present invention, when the communication device body is being held by one hand as well as when the communication device body is being worn to an arm, the influence of the human body can be avoided so that the efficient transmission and reception can be carried out.

In addition, according to the arm wear type communication device of the present invention, when the communication device body is being held by one hand as well as when the communication device body is being worn to an arm, the electric wave shielding function due to the coating can be avoided and also the efficient transmission and reception can be carried out with the influence of the human body avoided.

Also, according to the high dielectric chip antenna of the present invention, the shape of the high dielectric chip antenna can be fitted to the various shapes each of which the wear body adapted to be fitted to the arm shape has. Moreover,

this high dielectric chip antenna can be accommodated in the thin wear body. If the antenna pattern is suitably selected, then the miniaturization of the antenna becomes possible. Thus, even if the chip antennas are accommodated in a plurality of places of the wear bodies, this is not a hindrance to the manipulation of the communication device. Even when the antennas are accommodated in a plurality of places of the wear bodies, if these antennas are controlled, then the diversity reception which suffers the less influence of the fading commonly associated with the mobile telecommunication becomes possible. Such a high dielectric chip antenna can cause the flat surface of the wear body to have the directivity depending on the installation direction. If the single surface is caused to have the directivity, then it is possible to maintain the directivity which is convenient for when the arm wear type communication device is being worn to an arm and when the communication device body is being held by one hand.